Artificial Intelligence (AI) for Safety-Critical Systems

ikerlan MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

Promising technologies for ECS
22nd September 2022

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VISIT…

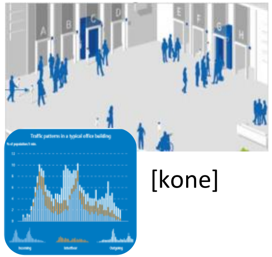
LANZAROTE Caliente.com

AGENDA

- Introduction
- Safety standards
- ML development (training)
- ML development (inference)
- Trustworthiness
- Conclusion

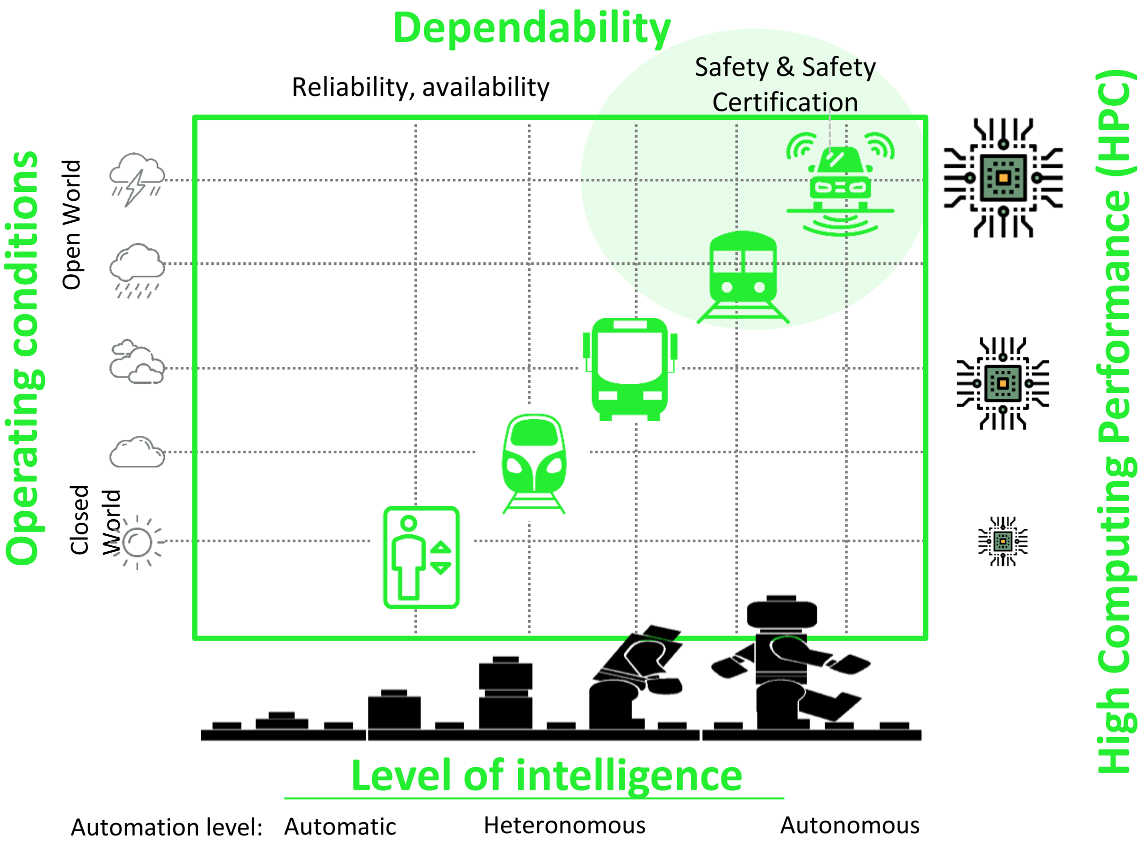
Example AI and dependable / Safety systems

[guard]



[kone]

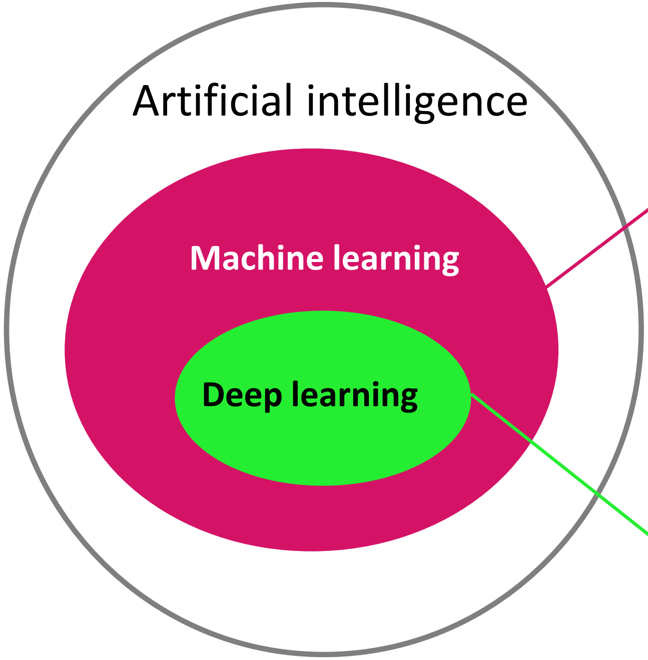
[Pe20b]



[ver]

[mov]

Machine learning



[Pe20b]

Linear regression.
Logistic regression.
Bayesian networks.
Decision tree.
Greedy algorithm.
Support Vector Machine (SVM).
Naive bayes.
Random forest.
Gradient boosting algorithm.
....

Neural Network (NN).
Deep learning.
Recurrent Neural Network (RNN).
Long Short Term Memory (LSTM).
.....

Artificial Intelligence [ISO 22989]:

"set of methods or automated entities that together build, optimize and apply a model so that the system can, for a given set of predefined tasks, compute predictions, recommendations, or decisions"

Machine Learning [Oxford]:

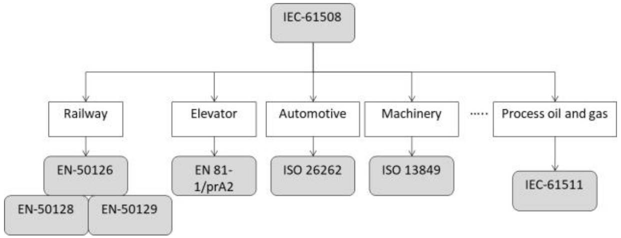
"the use and development of computer systems that are able to learn and adapt without following explicit instructions, by using algorithms and statistical models to analyze and draw inferences from patterns in data"

Scope


Updates
ML Development (Training)
ML Development (Training)
SAFETY STANDARDS
Trustworthiness

Safety standards

Functional Safety (Traditional)



Het./Autonomous Systems Artificial intelligence

Drafts:

- **ISO/PAS 21448**: Road vehicles — Safety of the intended functionality (**SOTIF**).
- **UL 4600** - Safety for the evaluation of autonomous products.
- **ISO/IEC AWI TR 5469**: artificial intelligence — functional safety and AI systems.
- **VDE-AR-E 2842-61-1**: Development and trustworthiness of autonomous/cognitive systems
- Etc.

Working Groups: EUROCA WG-114, SAE G-34, etc.

Scope

Updates

ML Development (Training)

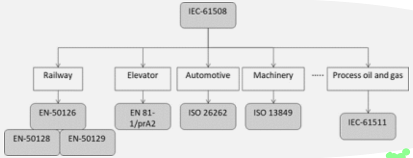
ML Development (Training)

SOTIF, UL 4600, IEC 5469

Artificial intelligence, autonomous systems and safety (draft) standards

Safety standards

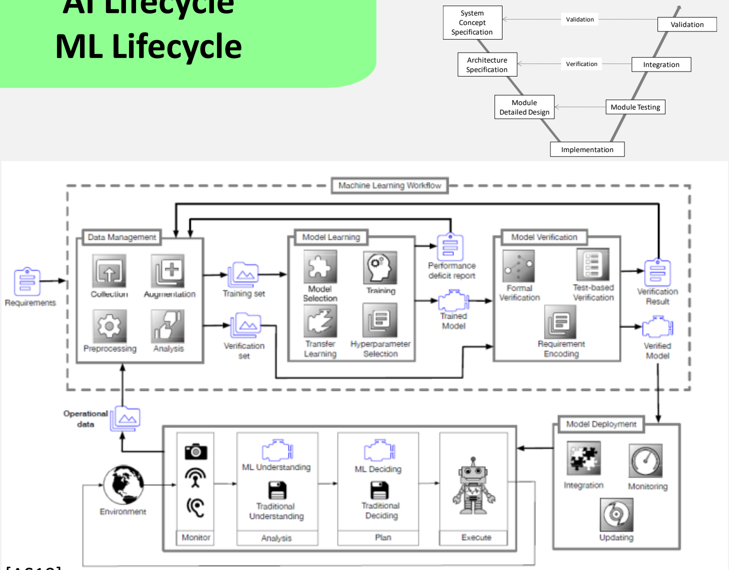
Functional safety standards: electronics / programmable electronics



Trustworthiness

Safety standards

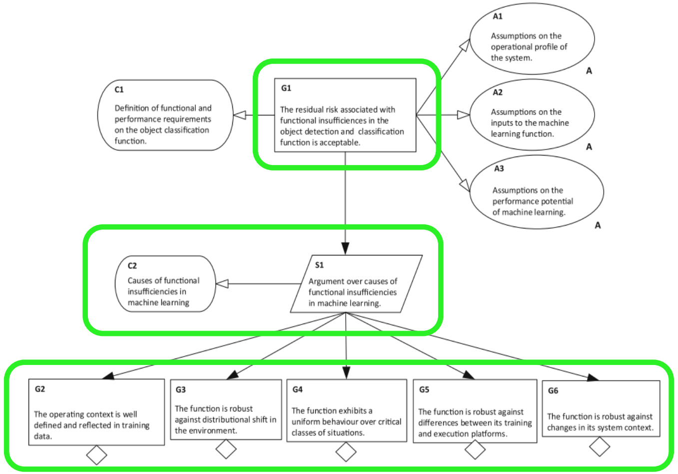
AI Lifecycle
ML Lifecycle



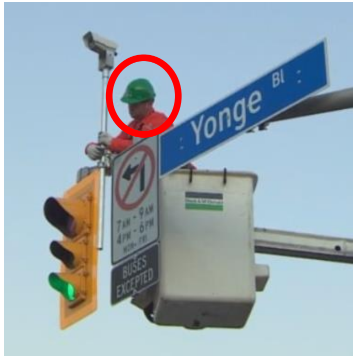
[AS19]

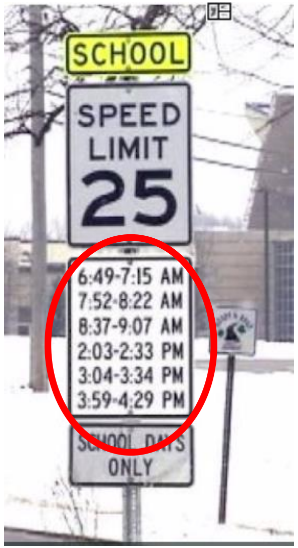
Fig. 1. The machine learning lifecycle

Example safety case
[Bu17] – GSN



Development (training)





[cbc, hre, Ka18]

Scope

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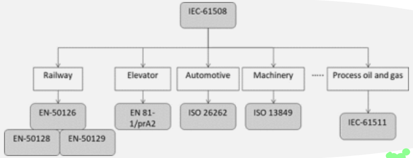


Trustworthiness

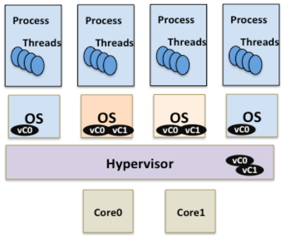
Deployment (inference)

Hardware device

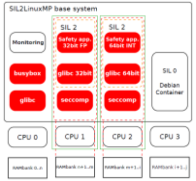
- Multi-core devices and MPSoCs [Pe20]
- GPUs [Ko19, Le18, Pe22]
- FPGAs [Ko19]
- Specialized devices, e.g., TPU
- Proprietary devices, e.g. Tesla FSD [Ta20]

Software

Hypervisor



Operating system



Domain specific runtime env.

Parallel Programming Runtimes

High-Performance Embedded Computing (HPEC) – Hardware and software.

- Safety compliance of ‘Parallel Programming runtime’ and ‘ML software libraries’ .
- Temporal Independence, guarantees and diagnosis [Pe20].
- Spatial independence [Pe20].
- Diagnosistic coverage (DC) [Pe20].
- Thermal dissipation, energy consumption [Ko19].

Deployment (inference)

Hardware device

- Multi-core devices and MPSoCs [Pe20]
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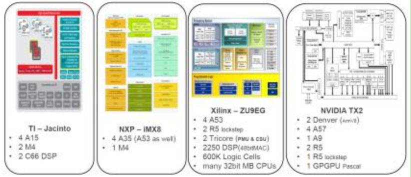
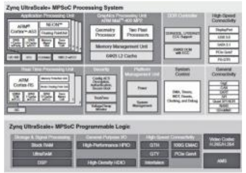
[Co17]

Generic purpose computing



[Co17] [nvidia]

Safety Std. Compliance and support



[xilinx]

Specialized computing solutions

[mbeye]

High-Performance Embedded Computing (HPEC) – Hardware and software.

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Scope

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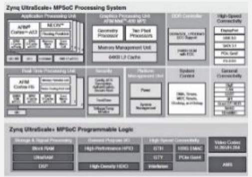

SOTIF, UL 4600, IEC 5469

Artificial intelligence, autonomous systems and safety (draft) standards

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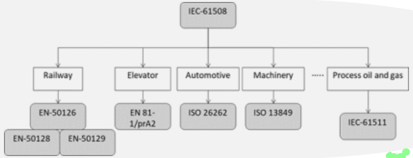
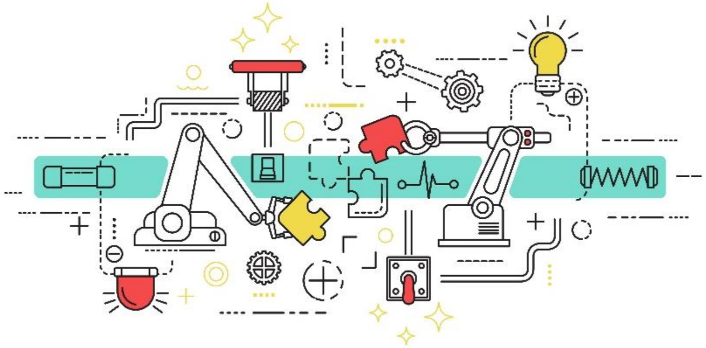


Trustworthiness

Trustworthiness



Engineering

Ethics

Legal

Engineering Ethics

Machine Ethics

EUROPEAN COMMISSION

Brussels, 21.4.2021

COM(2021) 206 final

2021/0106(COD)

Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

LAYING DOWN HARMONISED RULES ON ARTIFICIAL INTELLIGENCE (ARTIFICIAL INTELLIGENCE ACT) AND AMENDING CERTAIN UNION LEGISLATIVE ACTS

CONCLUSION

There is a need to pave the way towards the development and certification of AI-based safety systems:

- Need for AI safety standard(s) definition and consolidation, complementary with functional safety standards.
- Many ML technical challenges: training data coverage (e.g., corner cases), understability, testability, verifiability, etc.
- Evolution of HPC challenges (HW / SW): integration of functions of different criticality in a HPC safe execution platform:
  - Safety compliance of ML libraries and parallel programming languages.
  - Temporal and spatial independence.
  - Thermal and energy requirements.
- Trustworthiness: Engineering, Ethics and Legal
- Safe and secure update of systems

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THANK YOU

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